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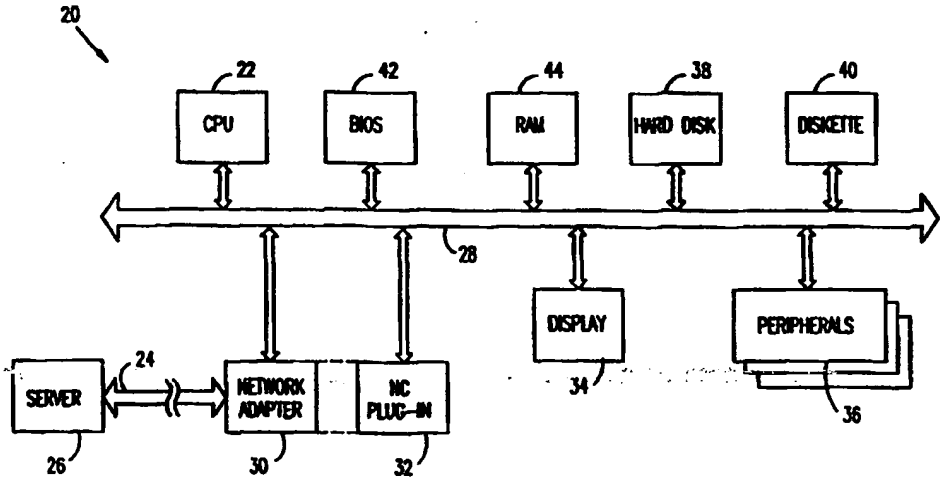

(57) Abstract

A device for controlling a boot-up process of a computer (20), including a plug-in component (32), which is inserted into a socket on a bus (28) accessible to a CPU (22) of the computer. The component includes a memory (50) which receives a starting address in an address space of the CPU and in which memory one or more software files (60) including an operating system file (62) are stored. During a start-up sequence of the computer, the CPU addresses the starting address and reads the operating system file from the memory, causing the computer to boot as a thin client of a network server (26) to which the computer is coupled, substantially under the control of instructions in the operating system file in the memory.

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COMPUTER ADAPTER CARD

FIELD OF THE INVENTION

The present invention relates generally to personal computers, and specifically to "thin-client" personal computer networking.

BACKGROUND OF THE INVENTION

Thin-client computers have begun to emerge as the middle ground between traditional terminal/host systems and PC-based client/server networks. Thin-client computers are designed to be centrally-managed, configured with only essential equipment, and typically do not include a CD-ROM player, diskette drive or other peripheral components generally found in PCs. Application software and data are stored on a server, which provides most of the system resources, to be accessed and down-loaded by the thin client as needed. Thin-client/server systems provide enterprises with more orderly, centralized system management and maintenance than do PC-based "thick-client" networks, while allowing users complete access to PC-type applications running under Windows and other operating systems. Programs and data are generally loaded only through the server, so that the chances that one of the clients will introduce a virus or otherwise corrupt the network system are greatly reduced.

The term "thin client" is applied to a wide range of different computers, having different levels of local resources. At one end of the thin client scale are smart terminals, such as the IBM 5250 and 3270 types and the Digital Equipment Corporation VTxxx series, or Windows terminals produced by Wyse Corporation. Although such terminals have local processing capability, which may be used to run agraphic user interface (GUI), for example, substantially all applications execute on the server. At the other end is the "Net PC," developed primarily by Intel and Microsoft, which has a local disk and runs Windows applications on its own Intel microprocessor. Although thin clients are most often

envisioned as connecting to the server through a LAN, the link to the server may also be through other communication lines, such as a WAN, a mainframe/terminal connection or even a modem line. In the context of the present patent application and in the claims, the term "thin client" is used in the broad sense that this expression has acquired in the art, as described hereinabove.

The Network Computer (NC) is a new standard, also known as NCRP-1, developed by IBM, Oracle and Sun Microsystems, which defines a thin-client system using Java-based software technology. In a NC system, some applications may be designed to execute on the client, while others run on any one of a variety of servers. After the NC is booted, it can download Java applets and other programs from a server to run locally, connect to remote applications running on servers over Internet or intranet networks, and perform terminal emulation to access mainframe data and programs. Unlike PCs, the NC is free of any dependence on a particular operating system and can thus access simultaneously Java applications running on Windows NT, UNIX and other operating platforms.

NC client devices introduced to date, primarily by IBM, are typically small boxes that connect to a standard monitor, keyboard and mouse. They are similar in functionality to a PC with a network card but without diskette and disk drives. A conventional "thick" PC, which boots its own operating system (typically Windows) from a local disk, will generally not be compatible with a thin-client/server LAN designed for NCs. Potential adopters of NC systems are therefore faced with the problem of immediate obsolescence of their current PCs.

In response to this problem, Sun Microsystems has announced the development of a software package for PCs, known as "Java PC," designed to make them operable as NCs. Because this software will have to run under the PC's local operating system, however, it will have to deal with the large range of variations that exist in PC operating systems and configurations, which is one of the factors that currently

cause difficulty in thick-client network management. Furthermore, because the local user can still access the PC disk and diskette drive, the network may become corrupted by viruses and incompatible software versions that the user may introduce.

U.S. Patent 5,680,547, to Chang, which is incorporated herein by reference, describes a method and apparatus for controlling network and workstation (PC) access prior to workstation boot, in order to avoid conflicts and problems of incompatibility between the workstation operating system and network applications. A ROM or PROM with appropriate programming is placed in the workstation, typically on the motherboard, or else in the usually unused boot ROM socket on a LAN card installed in the workstation. The ROM or PROM includes an operating system kernel and a command interface for communicating with a network server to which the workstation is to be connected. At system startup, the workstation BIOS program (assuming the workstation to be a PC) is executed and detects the presence of the ROM or PROM program. Control is passed to this program, which loads communications software from the workstation disk and establishes network communications with the server. At this point, control is passed to a Server Management Application (SMA) running on the server, allowing the server to access the workstation hard disk drive and perform functions on the workstation such as identification and authentication, configuration management and software updates. After completion of the SMA functions, control is returned to the normal workstation boot process, and the complete workstation operating system is loaded from the disk in a normal fashion.

French Patent Application 2,630,558, to Blanie, which is incorporated herein by reference, describes a microcomputer with a plug-in board, which includes a memory containing a program for terminal emulation or communications with a central computer. The board and the program contained thereon enable the microcomputer, which has booted up on a native operating

system, to perform the functions of a terminal in connection with central computers running different operating systems.

SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide apparatus and methods to enable a personal computer (PC) to function as a thin client.

It is a further object of some aspects of the present invention to enable a PC having a local disk to function in a thin client/server environment while access to the local disk is disabled.

It is yet another object of some aspects of the present invention to enable a PC to function as a thin client independent of the PC's own operating system.

In preferred embodiments of the present invention, a plug-in card is inserted into a slot on the bus of a PC, which is connected to a network. The card includes a non-volatile memory in which thin client operating system software is stored, and which receives a predetermined starting address in a memory range of the PC. When the PC begins its normal start-up procedure, generally at power-on, the CPU of the PC is directed to the predetermined address, preferably by instructions stored in a standard BIOS memory associated with the CPU. The CPU reads the software stored in the memory on the card, and consequently boots up as a thin client, in conjunction with a suitable server accessed via the network.

The PC preferably continues to function as a thin client, under control of the operating system on the plug-in card, until it is switched off. A user of the PC under these conditions preferably has no access to a local hard disk, diskette or other mass-memory peripheral that may be connected to the PC (except possibly through the server, if the network is so configured). Although in the absence of the plug-in card, the BIOS would direct the PC to load its operating system, such as DOS or Windows, from the local disk, the software on the card intercepts the normal boot sequence, and

loads the thin client operating system instead. Control is not returned to the local disk at any stage of the boot process. Thus, the present invention enables the PC to function as a thin client independent of the PC's normal operating system and substantially without modification to a motherboard of the PC. Furthermore, because the user's local disk and diskette are entirely neutralized, the present invention prevents corruption of the network system and introduction of viruses from the PC.

The term "PC" as used in describing preferred embodiments of the present invention refers to an industry-standard personal computer, which is typically designed to run on DOS and/or Windows-based software, as are well known in the art. The term "thin client" is used in the broad sense defined in the Background of the Invention. "NC" or "Network Computer" as used herein refers to a thin-client computer operating on a network, preferably in accordance with the NCRP-1 standard mentioned above. Although some preferred embodiments are described herein with reference to these PC and NC standards, it will be appreciated that the principles of the present invention may similarly be applied to other types of computers, such as UNIX-based workstations, and to other types of thin-client networks, such as those described in the Background of the Invention.

In some preferred embodiments of the present invention, the plug-in card containing the thin client operating system software also serves as the PC network card and includes a suitable network adapter and control hardware. In other preferred embodiments, the plug-in card is separate from the network card. Depending on the bus type of the PC, the plug-in card may be adapted to work on an ISA, EISA or PCI bus, or may conform to any other suitable standard or non-standard bus configuration.

In some preferred embodiments of the present invention, the non-volatile memory on the plug-in card comprises a Flash or EEPROM memory, as are known in the art. Such memories have the advantage that the software stored therein may be updated

without removing the card from the computer, typically by downloading a software update, together with appropriate commands for rewriting the appropriate part of the memory, from the server. Alternatively, the non-volatile memory may comprise any suitable type of NVRAM, EPROM, PROM or ROM. In any case, the plug-in card has the advantage that it allows the PC to be converted to a NC at minimal cost, independently of the PC's local operating system and with fewer potential complications than purely software-based solutions.

There is therefore provided, in accordance with a preferred embodiment of the present invention, a device for controlling a boot-up process of a computer, including:

a plug-in component, which is inserted into a socket on a bus accessible to a CPU of the computer, the component including a memory which receives a starting address in an address space of the CPU and in which memory one or more software files including an operating system file are stored,

such that during a start-up sequence of the computer, the CPU addresses the starting address and reads the operating system file from the memory, causing the computer to boot as a thin client of a network server to which the computer is coupled, substantially under the control of instructions in the operating system file in the memory.

Preferably, the computer includes a local mass memory device, such as a disk, from which the computer boots in the absence of the plug-in component, and the computer reads the operating system file from the memory in the plug-in component and boots therefrom instead of from an operating system file in the mass memory device. Most preferably, the computer boots from the memory in the plug-in component substantially without accessing the mass memory device. Further preferably, files stored in the mass memory device are substantially inaccessible to a user of the computer while the computer is under the control of the instructions in the operating system file in the memory of the plug-in component.

Preferably, the plug-in component includes a printed circuit board, and the socket on the bus includes a slot into which the board is inserted. In a preferred embodiment, the board includes network communications circuitry, through which the computer is coupled to the network server.

Preferably, the computer includes a PC, and wherein the board plugs into an industry-standard bus slot.

Preferably, the memory in the plug-in component includes a non-volatile memory, most preferably a Flash memory.

In a preferred embodiment, the network server writes to one or more of the files in the memory in the plug-in component.

Preferably, the computer boots as a Network Computer. Alternatively, the computer boots as a computer terminal.

There is further provided, in accordance with a preferred embodiment of the present invention, apparatus for converting a personal computer (PC) having a CPU to a Network Computer (NC) client, including:

a plug-in card, which is inserted into a slot on a bus of the PC; and

a memory on the plug-in card, in which one or more software files including a NC operating system file are stored,

such that during a start-up sequence of the computer, the CPU reads the operating system file from the memory, so that the computer boots as a NC client in accordance with instructions in the operating system file.

Preferably, the computer is coupled to a network server, which is accessed when the computer boots in accordance with instructions in the operating system file stored in the memory.

In a preferred embodiment, the network server updates one or more of the software files in the memory.

In another preferred embodiment, the apparatus includes network communications circuitry on the card, through which the computer is connected to the network server.

Preferably, the memory includes non-volatile memory, most preferably Flash memory.

Preferably, the CPU is directed to read the operating system file from the memory by a start-up program stored in a BIOS memory associated with the CPU.

In a preferred embodiment, the PC includes a disk having files stored thereon, and in the absence of the card, the PC boots from the disk. Preferably, the PC boots as a NC substantially without reference to the files stored on the disk, and when the PC boots as a NC, the files on the disk are substantially inaccessible to a user of the computer.

There is also provided, in accordance with a preferred embodiment of the present invention, a method for booting up a computer, including:

inserting a plug-in component into a socket on a bus associated with a CPU of the computer, the component including a memory in which one or more software files including an operating system file are stored;

coupling the computer to a network server;

initiating a computer start-up sequence, which causes the CPU to read the operating system file from the memory in the component; and

completing the boot process substantially under the control of instructions in the operating system file, so that the computer boots up as a thin client of the network server.

Preferably, inserting the plug-in component includes allocating to the memory therein a starting address in an address space of the CPU, such that during the start-up sequence, the CPU addresses the starting address, whereby the CPU reads the operating system file from the memory. Most preferably, allocating the address includes allocating an address which the CPU reads in accordance with a start-up program stored in a BIOS memory associated with the CPU.

Preferably, the computer boots from a local mass memory device in the absence of the plug-in component, and completing the boot process includes booting the computer from the memory in the plug-in component instead of from the mass memory device. Most preferably, booting from the memory in the plug-

in component includes booting substantially without accessing the mass memory device, and completing the boot process includes rendering files stored in the mass memory device substantially inaccessible to a user of the computer. Typically, the mass memory device includes a disk.

Preferably, inserting the plug-in component includes plugging a card into a slot on the bus. In a preferred embodiment, coupling the computer to the network server includes connecting the computer to a network through network communications circuitry on the card. Preferably, the computer includes a PC, and plugging the card into the slot includes inserting the card into an industry-standard bus slot.

In a preferred embodiment, completing the boot process includes receiving changes to one or more of the files in the memory in the plug-in component from the network server.

Preferably, completing the boot process includes booting up the computer as a Network Computer or, alternatively, as a computer terminal.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic block diagram of a client computer connected to a network, in accordance with a preferred embodiment of the present invention;

Fig. 2A is a schematic illustration of a plug-in card for the computer of Fig. 1, in accordance with a preferred embodiment of the present invention;

Fig. 2B is a schematic illustration of a plug-in card for the computer of Fig. 1, in accordance with another preferred embodiment of the present invention;

Fig. 3 is a schematic block diagram illustrating a software program structure for use in the computer of Fig. 1, in accordance with a preferred embodiment of the present invention; and

Fig. 4 is a flow chart illustrating a start-up and boot sequence of the computer of Fig. 1, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 is a schematic block diagram illustrating a PC 20, in accordance with a preferred embodiment of the present invention. In this figure and in the description that follows, PC 20 is, for the sake of simplicity, represented and described as an industry-standard PC, with a single internal bus 28 linking all of its components. It will be understood, however, that the principles described hereinbelow may be applied in a straightforward way to personal computers and workstations having different internal configurations and bus structures, so long as they include the facility for connecting a plug-in card or other such component on the bus.

PC 20 includes a CPU 22, which may include a cache and/or other local memory and peripheral components, as well as a ROM (or PROM) 42 programmed with the basic input/output system (BIOS) that is read in by the CPU at power-up. The PC further includes other standard components known in the art, including a main RAM memory 44, a display 34 and other peripherals 36, including a keyboard and mouse (not shown) and, optionally, a hard disk 38 and a diskette drive 40, as well as sound and teleconferencing devices.

PC 20 also includes a thin client plug-in card 32, which causes the PC to boot up as a thin client of a server 26. Preferably, the card causes the PC to boot up as a Network Computer (NC), most preferably in accordance with the NC standard described hereinabove. In the absence of card 32, PC 20 would normally boot up from disk 38 or diskette drive 40 in a DOS or Windows operating system. Card 32 intercepts and takes control of the boot process, and prevents access to the operating system on the disk or diskette, as described further hereinbelow.

PC 20 is connected via a network adapter 30 through a network 24, preferably a LAN of any suitable type known in the art, to server 26. Server 26 may be of any suitable type known in the art, preferably operating under a Windows NT or UNIX operating system and preferably communicating with the PC using

the TCP/IP protocol. In some preferred embodiments of the present invention, the server is set up to operate opposite thin clients in the Network Computer (NC) operating environment, as described hereinabove, and is equipped with suitable software for this purpose, preferably including Network Station Manager code. Such code is known in the art and may be obtained from IBM or from Sun Microsystems. PC 20 operates as a NC thin client in this environment under the control of plug-in card 32, which may be either separate from or integrated with network adapter 30. The structure and operation of card 32 are described in detail hereinbelow.

Although in the present preferred embodiment network 24 comprises a LAN, PC 20 may also be connected to server 26 through any other suitable type of communication line known in the art. For example, network adapter 30 may be designed to couple the PC to a WAN; through a coax or twinax cable to a central computer; to a telephone or cable TV line; or even to a satellite modem.

Fig. 2A is a schematic illustration of card 32 having an edge connector 54 suitable for plugging into a standard socket on an ISA bus in PC 20, in accordance with a preferred embodiment of the present invention. Card 32, which in this case is separate from network adapter 30, includes a non-volatile memory 50, which is programmed with a suitable operating system, as described further hereinbelow. Memory 50 preferably includes Flash memory with a capacity of at least 4 Mbits, preferably along with other circuitry needed to allow the memory to be reprogrammed by server 26. Alternatively, the memory may comprise EEPROM, EPROM, PROM, NVRAM, or any other suitable type of non-volatile memory.

Card 32 in the configuration shown in Fig. 2A further includes DIP switches 52 for setting a starting address of memory 50 in the address space of CPU 22. The starting address is set to a value in an address range that is scanned by the CPU immediately after power-up, preferably between 640K and 1M, in accordance with program instructions stored in BIOS 42.

When the CPU reaches the starting address, it calls a routine stored in memory 50, which boots the thin client operating system (preferably the NC operation system, as described further in reference to Fig. 3). Most preferably, the starting address is near the beginning of the BIOS search range, so that the CPU reaches memory 50 and calls the routine before reaching any other devices that may be on the bus.

The thin client operating system supplants the DOS or Windows system on disk 38, and renders disk 38 and diskette drive 40 unavailable to a user of the PC. The user accesses all system resources not stored in memory 50, as well as all applications and data files, through network 24. If desired, the thin client operating system may include a software switch allowing the user or, more preferably, a system manager to restore certain local functions to PC 20, and in particular to access disk 38 and/or diskette drive 40. The availability of such functions, however, could tend to cause problems in network management and system maintenance, such as allowing viruses and deviant software versions to be introduced to the network. Therefore, these local functions are preferably unavailable to the user, and PC 20 functions exclusively as a thin client as long as card 32 remains in its slot on bus 28.

Fig. 2B is a schematic illustration showing card 32 having an edge connector 57 suitable for coupling to an EISA or PCI bus, in accordance with another preferred embodiment of the present invention. In this case, no DIP switches are required, since card 32 exploits the "plug and play" feature of more recent types of PC, as is known in the art. Similarly, in other embodiments (not shown in the figures), card 32 may comprise a PCMCIA connection, or any other suitable bus connection type. In the embodiment of Fig. 2B, card 32 also includes network communication circuitry 58 and a network connector 56, so that card 32 incorporates, as well, the functions of network adapter card 30. This configuration reduces the number of cards that must be plugged into bus 28 and ensures that the software stored in memory 50 will be

compatible with the network adapter. It also reduces the likelihood that a user will attempt to communicate over network 24 while local PC functions (such as disk 38) are active.

Fig. 3 is a block diagram illustrating software files 60 which are stored in memory 50, in accordance with a preferred embodiment of the present invention. When loaded by CPU 22, these programs in files 60 cause PC 20 to function as a NC thin client. Files 60 generally include an operating system 62, set-up and configuration files 68, management and control files 78 and applications 70. If memory 50 has sufficient capacity, it may be advantageous that all these programs be stored therein, so as to reduce the load on network 24. Typically, however, at least some of these programs, particularly applications 70, are stored on server 26 and are downloaded to RAM 44 of PC 20 on demand. In any case, the programs listed in Fig. 3 are shown by way of example: additional programs may be included in operating system 62 stored in memory 50, and additional applications 70 may also be included in memory 50 or, more typically, downloaded from server 26 or other network servers.

Operating system 62 generally includes device drivers 64 and communications drivers 66. The device drivers enable PC 20 (in the thin client operating mode) to access the display, keyboard, mouse, sound card and other peripherals associated with the PC, such as teleconferencing equipment. The communications drivers enable the PC to communicate with server 26, preferably using TCP/IP. They may also enable the PC to access other communications facilities that are available, such as telecommunications modems and terminal emulation hook-ups to mainframe and minicomputers.

Application programs 70 may include substantially any type of network applications. In the preferred embodiment shown in Fig. 3, they include client/server applications 72, terminal emulation 74, Java functions 76 and a Web browser 77. The client/server applications preferably include WinFrame client software, produced by Citrix, which enables PC 20 to work with

server 24 running Windows NT, and/or other, equivalent client software produced by other manufacturers, and optionally, software for working with other server operating systems. Terminal emulation programs 74 may include IBM 5250 and 3270 applications, for working with IBM AS-400 and mainframe computers, respectively, as well as VTxxx (such as VT100 and VT420) applications, in accordance with standards established by Digital Equipment Corporation. Java software 76 enables interoperability of PC 20 (in NC mode) with any intranet or Internet server by downloading Java applets, as described above. For this purpose, the Java applications available to PC 20 preferably include Java Virtual Machine (JVM) software, available from Sun Microsystems, for example.

Fig. 4 is a flow chart illustrating a method for booting up PC 20 in the thin client mode described above, in accordance with a preferred embodiment of the present invention. When the PC is powered up, CPU 22 addresses BIOS 42, which runs its basic pre-boot start-up and diagnostic programs, irrespective of the presence of plug-in card 32. In accordance with the program stored in the BIOS, the CPU begins to scan the range of its memory at addresses between 640K and 1M, and detects operating system software 62 at the starting address of memory 50. Operating system 62 is loaded and instructs CPU to continue booting up from memory 50, rather than from disk 38 as it would ordinarily do.

Once drivers 64 and 66 (or at least the necessary network communications drivers) have been loaded, CPU 22 initiates a network connection with server 26. Server 26 responds by assigning PC 20 an IP address and sending the address over the network to the PC, along with any other necessary boot parameters. At this point, the server may also perform remote diagnostics on PC 20, and may access the PC's set-up and configuration files 68 and management and control functions 78, as well as updating other operating system and application files stored in memory 50, as described, for example, in the above-referenced U.S. Patent 5,680,547.

After server 26 has completed these functions, CPU 22 resumes the boot procedure and commences a log-on sequence. The procedure is based on files 60 in memory 50 and other files that may be downloaded from server 26, and not on operating system files on disk 38 or diskette 40. Typically, in the log-on sequence, the user of PC 20 will be prompted to enter identification and/or password information. This information is verified by server 26. The server then downloads to the PC system and application files appropriate for the particular user. At this point, the PC can complete its boot-up as a thin client, preferably presenting on display 34 a graphic user interface (GUI) including icons that the user can select to invoke various applications, such as terminal emulations 74, Java and Web applications 76, and any other applications available on server 26.

Although the preferred embodiments described hereinabove make reference to particular types of personal computers and servers and are based generally on the Network Computer (NC) standard, it will be appreciated that the principles of the present invention are not limited to a particular computer or network type. Generally speaking, plug-in cards or other such devices may be produced in accordance with the principles of the present invention for use in any of a wide variety of microcomputers and workstations and various thin-client networks.

It will be appreciated that the preferred embodiments described above are cited by way of example, and the full scope of the invention is limited only by the claims.

CLAIMS

1. A device for controlling a boot-up process of a computer, comprising:

a plug-in component, which is inserted into a socket on a bus accessible to a CPU of the computer, the component comprising a memory which receives a starting address in an address space of the CPU and in which memory one or more software files including an operating system file are stored,

such that during a start-up sequence of the computer, the CPU addresses the starting address and reads the operating system file from the memory, causing the computer to boot as a thin client of a network server to which the computer is coupled, substantially under the control of instructions in the operating system file in the memory.

2. A device according to claim 1, wherein the computer includes a local mass memory device from which the computer boots in the absence of the plug-in component, and wherein the computer reads the operating system file from the memory in the plug-in component and boots therefrom instead of from an operating system file in the mass memory device.

3. A device according to claim 2, wherein the computer boots from the memory in the plug-in component substantially without accessing the mass memory device.

4. A device according to claim 2, wherein files stored in the mass memory device are substantially inaccessible to a user of the computer while the computer is under the control of the instructions in the operating system file in the memory of the plug-in component.

5. A device according to claim 2, wherein the mass memory device comprises a disk.

6. A device according to any of claims 1-5, wherein the plug-in component comprises a printed circuit board, and wherein the socket on the bus comprises a slot into which the board is inserted.

7. A device according to claim 6, wherein the board includes network communications circuitry, through which the computer is coupled to the network server.

8. A device according claim 6, wherein the computer comprises a PC, and wherein the board plugs into an industry-standard bus slot.

9. A device according to any of claims 1-5, wherein the memory in the plug-in component comprises a non-volatile memory.

10. A device according to claim 9, wherein the non-volatile memory comprises Flash memory.

11. A device according to any of claims 1-5, wherein the network server writes to one or more of the files in the memory in the plug-in component.

12. A device according to any of claims 1-5, wherein the computer boots as a Network Computer.

13. A device according to any of claims 1-5, wherein the computer boots as a computer terminal.

14. Apparatus for converting a personal computer (PC) having a CPU to a Network Computer (NC) client, comprising:

a plug-in card, which is inserted into a slot on a bus of the PC; and

a memory on the plug-in card, in which one or more software files including a NC operating system file are stored,

such that during a start-up sequence of the computer, the CPU reads the operating system file from the memory, so that the computer boots as a NC client in accordance with instructions in the operating system file.

15. Apparatus according to claim 14, wherein the computer is coupled to a network server, which is accessed when the computer boots in accordance with instructions in the operating system file stored in the memory.

16. Apparatus according to claim 15, wherein the network server updates one or more of the software files in the memory.

17. Apparatus according to claim 15, and comprising network communications circuitry on the card, through which the computer is connected to the network server.

18. Apparatus according to any of claims 14-17, wherein the memory comprises non-volatile memory.

19. Apparatus according to claim 18, wherein the non-volatile memory comprises Flash memory.

20. Apparatus according to any of claims 14-17, wherein the CPU is directed to read the operating system file from the memory by a start-up program stored in a BIOS memory associated with the CPU.

21. Apparatus according to any of claims 14-17, wherein the PC includes a disk having files stored thereon, and wherein in the absence of the card, the PC boots from the disk.

22. Apparatus according to claim 21, wherein the PC boots as a NC substantially without reference to the files stored on the disk.

23. Apparatus according to claim 21, wherein when the PC boots as a NC, the files on the disk are substantially inaccessible to a user of the computer.

24. A method for booting up a computer, comprising:

inserting a plug-in component into a socket on a bus associated with a CPU of the computer, the component including a memory in which one or more software files including an operating system file are stored;

coupling the computer to a network server;

initiating a computer start-up sequence, which causes the CPU to read the operating system file from the memory in the component; and

completing the boot process substantially under the control of instructions in the operating system file, so that the computer boots up as a thin client of the network server.

25. A method according to claim 24, wherein inserting the plug-in component comprises allocating to the memory therein a starting address in an address space of the CPU, such that during the start-up sequence, the CPU addresses the starting address, whereby the CPU reads the operating system file from the memory.

26. A method according to claim 25, wherein allocating the address comprises allocating an address which the CPU reads in accordance with a start-up program stored in a BIOS memory associated with the CPU.

27. A method according to any of claims 24-26, wherein the computer boots from a local mass memory device in the absence of the plug-in component, and wherein completing the boot process comprises booting the computer from the memory in the plug-in component instead of from the mass memory device.

28. A method according to claim 27, wherein booting from the memory in the plug-in component comprises booting substantially without accessing the mass memory device.

29. A method according to claim 27, wherein completing the boot process comprises rendering files stored in the mass memory device substantially inaccessible to a user of the computer.

30. A method according to claim 27, wherein the mass memory device comprises a disk.

31. A method according to any of claims 24-26, wherein inserting the plug-in component comprises plugging a card into a slot on the bus.

32. A method according to claim 31, wherein coupling the computer to the network server comprises connecting the computer to a network through network communications circuitry on the card.

33. A method according to claim 31, wherein the computer comprises a PC, and wherein plugging the card into the slot

comprises inserting the card into an industry-standard bus slot.

34. A method according to any of claims 24-26, wherein completing the boot process comprises receiving changes to one or more of the files in the memory in the plug-in component from the network server.

35. A method according to any of claims 24-26, wherein completing the boot process comprises booting up the computer as a Network Computer.

36. A method according to any of claims 24-26, wherein completing the boot process comprises booting up the computer as a computer terminal.

FIG. 1

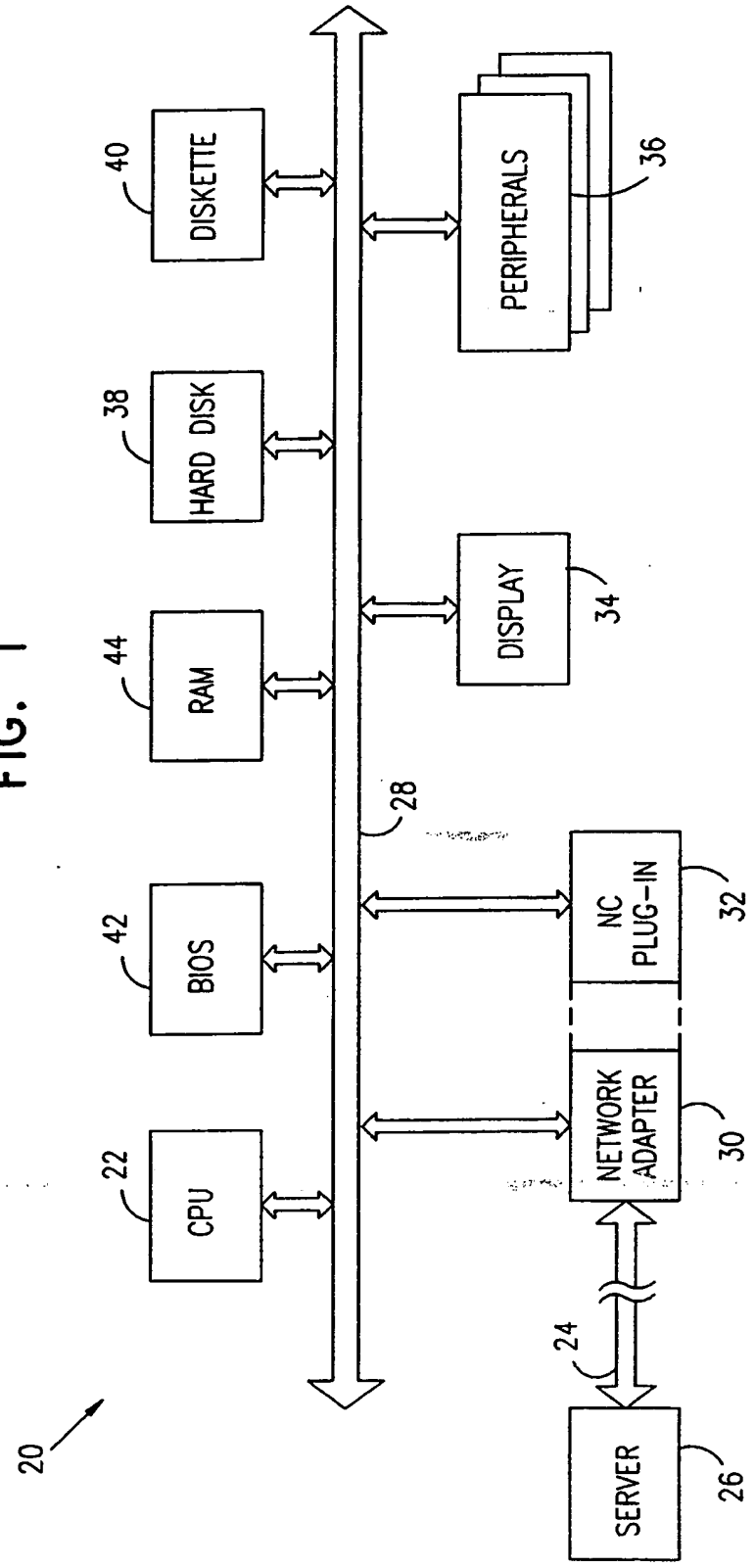

20
CPU
22
BIOS
42
RAM
44
HARD DISK
38
DISKETTE
40
28
PERIPHERALS
36
DISPLAY
34
NC PLUG-IN
32
NETWORK ADAPTER
30
24
SERVER
26

FIG. 2A

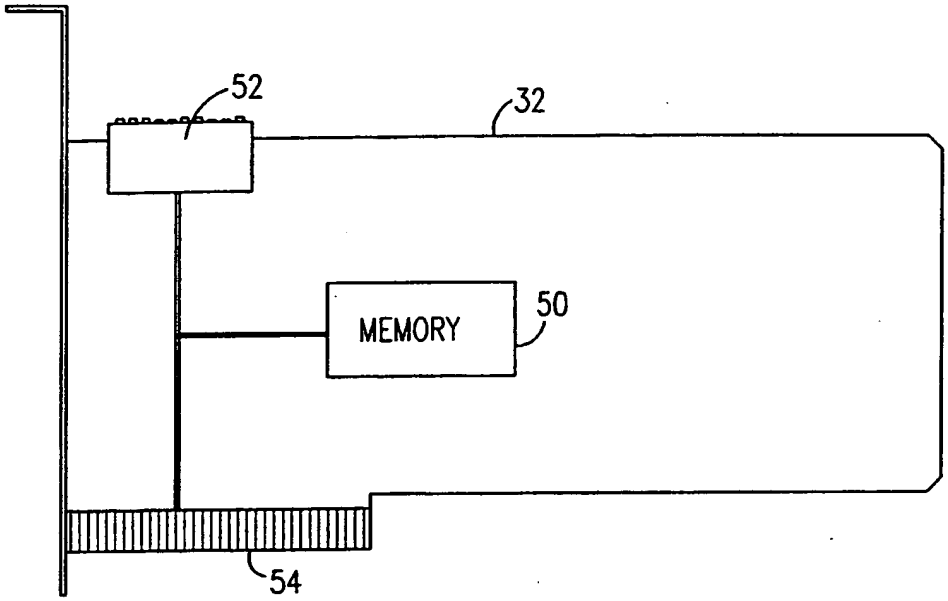
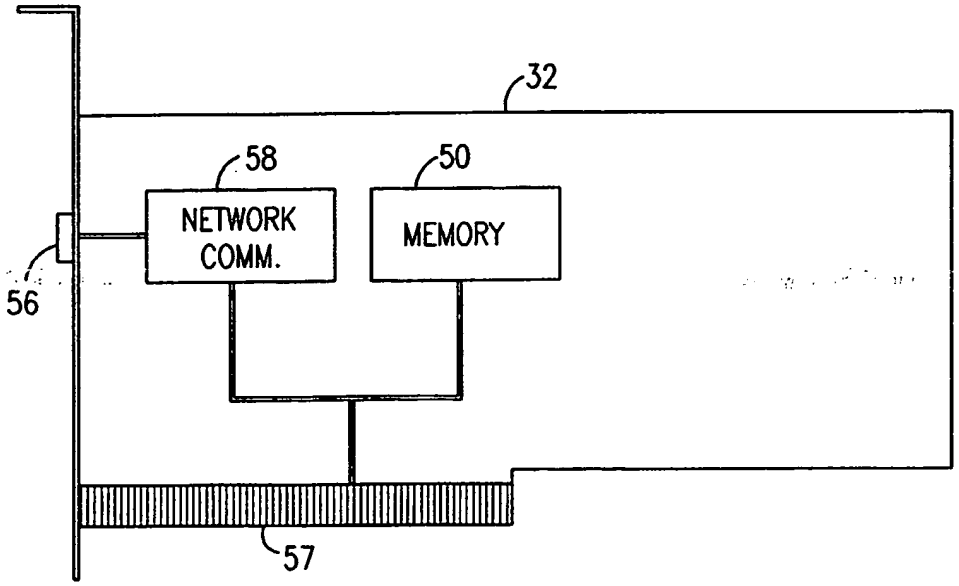


FIG. 2B



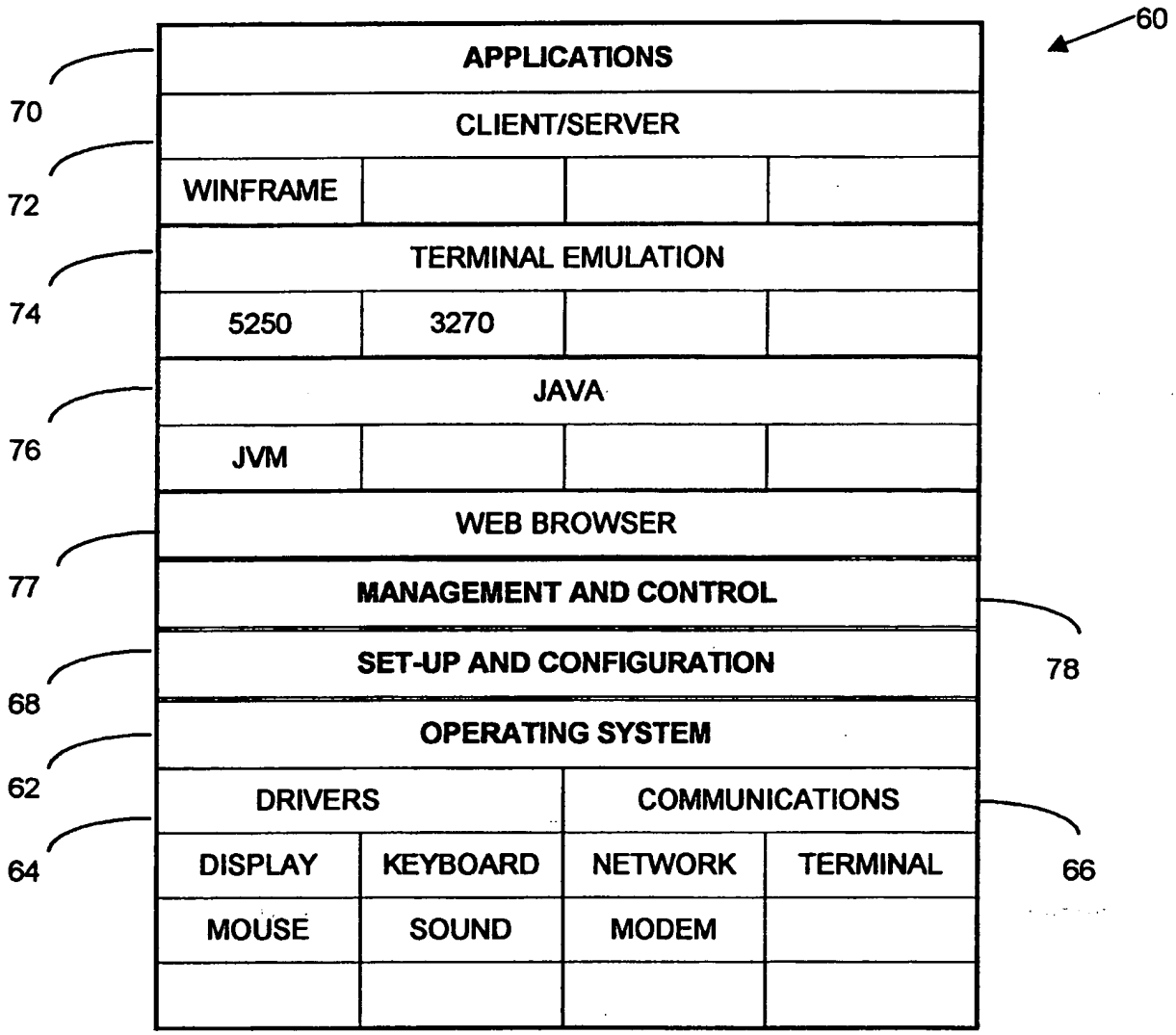

60
APPLICATIONS
70
CLIENT/SERVER
72
WINFRAME
TERMINAL EMULATION
74
5250
3270
JAVA
76
JVM
WEB BROWSER
77
MANAGEMENT AND CONTROL
78
SET-UP AND CONFIGURATION
68
OPERATING SYSTEM
62
DRIVERS
COMMUNICATIONS
64
DISPLAY
KEYBOARD
NETWORK
TERMINAL
66
MOUSE
SOUND
MODEM

FIG. 3

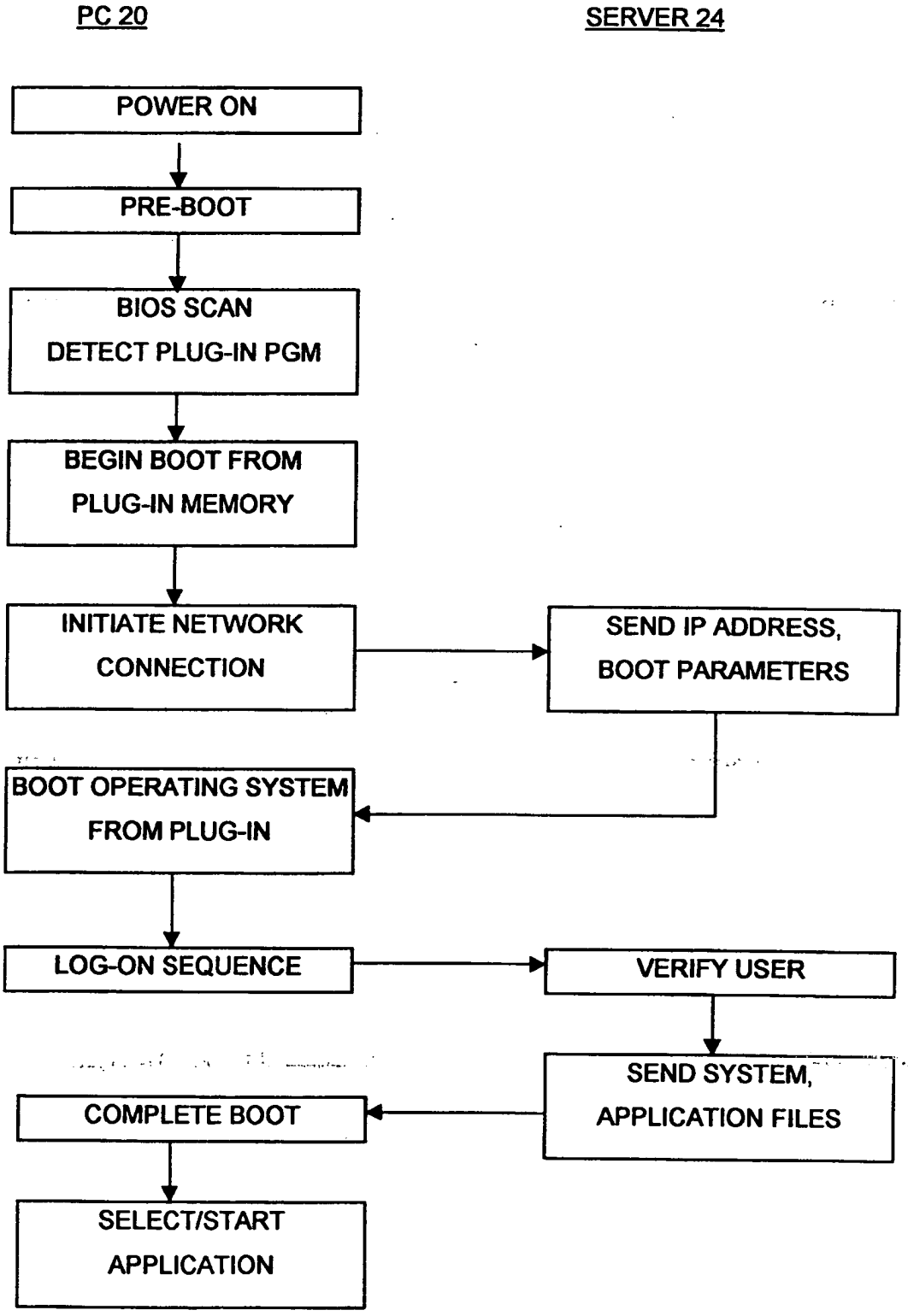

PC 20
SERVER 24
POWER ON
PRE-BOOT
BIOS SCAN
DETECT PLUG-IN PGM
BEGIN BOOT FROM
PLUG-IN MEMORY
INITIATE NETWORK
CONNECTION
SEND IP ADDRESS,
BOOT PARAMETERS
BOOT OPERATING SYSTEM
FROM PLUG-IN
LOG-ON SEQUENCE
VERIFY USER
SEND SYSTEM,
APPLICATION FILES
COMPLETE BOOT
SELECT/START
APPLICATION

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL99/00069

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :G06F 15/177; G06F 9/445
US CL : 713/2; 709/219, 222
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 713/2; 709/202, 219, 222; 395/712; 710/47

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Microsoft Press Computer Dictionary

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
APS, DERWENT West 1.1a, PC Webopedia
search terms: thin client, net pc, network pc, fat client, thick client, boot?, initial?, plugin, plug-in

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,680,547 A (CHANG) 21 October 1997, abstract, Brief Sunmmary of Invention, cols. 2-3, col. 5, lines 38-65, col. 6, line 34 - col. 7, line 27	1-36
A	US 5,701,491 A (DUNN et al.) 23 December 1997, col 1, lines lines 14-18, 35-51, col. 3, lines 40-53, col. 4, lines 58-65, col. 5, lines 36-39, col. 7, lines 16-19, 42-48	1-36
A, P	US 5,799,187 A (MCBEARTY) 25 August 1998, abstract, cols. 8-9 description of Figure 4	1-36
A	US 4,377,852 A (THOMPSON) 22 March 1983, abstract, col. 1, line 58 - col. 2, line 16, col. 11, lines 1-12	1-36

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
05 JUNE 1999

Date of mailing of the international search report
15 JUN 1999

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL99/00069

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Hewlett Packard, HP Netstations, About Thin Clients: Thin Clients harness the Power of the Net, pages 1-2, 25 January 1998	1-36
A	Hewlett Packard, HP Netstations Brochure: Introducing An Industry Leading Thin Client Solution, pages 1-8, 25 Jaunary 1998	1-36